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IMPROVING PRODUCTIVITY BY REDUCING WASTAGES IN MANUFACTURING PROCESS

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ABSTRACT

This project aims to reduce the wastages and the overall lead time in the manufacturing process for one of the crankshaft industries using Value Stream Map (VSM) and some other lean tools. It also aims to reduce the non-value-added activities in the manufacturing line to make the line more effective and to keep the production aligned. Here we have used Value Stream Map. First, the manufacturing line data was collected from the industry. Then current state map was drawn. By analyzing the current state map, non-value-added activities were identified which also includes some types of wastages. The wastes which we identified were the unnecessary motion of the component as well as the worker, inventory pile up and excessive scrap generation, rework on the component. The leans tools were used to reduce these wastes. The tools which we used are Kaizen, Poka Yoke, and some other quality tools. A future state map was drawn with the new and improved processes. This ensures that the processes are more effective and efficient. The result of this project was excellent as we were able to increase the process ratio by 8.69%. Therefore it is effective to use lean tools on the manufacturing processes in the industries.

KEYWORDS: Value Stream Mapping (VSM), Lean Tools, Value Added Time, Non Value Added Time, Productivity & Wastages

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Original Article

1. INTRODUCTION

Today's challenge for many industries is to reduce waste in order to increase their productivity and to provide a quality product. Customers are always willing to pay for quality products at optimum cost. So industries need to improve their productivity so that they can deliver good quality products. Productivity improvement helps the industries to achieve excellence in manufacturing and also to achieve good operational as well as good financial performance. So to improve productivity, lean tools are used in every sector. Usually, there are seven types of waste identified in industries which are: unnecessary transportation or handling of the materials and the component, excess inventory, unnecessary motion, waiting, over-processing, over-production, and defects in the final product.

Lean tools are the tools that are used for identifying and removing waste to increase process efficiency. The main purpose of implementing the lean tools is to increase the productivity of the manufacturing process, to reduce the lead time from the process, to reduce the cost, and to improve the quality of the product which eventually leads to customer satisfaction[1].In this project, different types of lean tools are used for reducing different types of wastages. The tools which were used are Value Stream Mapping, Kaizen, Poka Yoke.

Value Stream Mapping is the tool that shows operational waste and how to visualize the work, the broader use of value stream mapping as a methodology to transform leadership thinking and assure that customers are receiving a high level of value[2]. Lean tools are the tools that are used for identifying and removing waste to increase process efficiency. It is difficult to use VSM in the case of multiple flows that merge[3].The use of VSM as a tool for the detection of waste as a support for the implementation of the Lean philosophy has reached the most diverse sectors of activity and has contributed to eliminating some outdated concepts. This paper aims to be a contribution to the organizations, showing how they can detect the wastes in the productive flow through VSM. In addition to the detection of waste, this article intends to show several lean tools that can be applied in different situations, as well as the wastes that each can eliminate, and the benefits that are obtained from each one[4].

The objectives of the paper are as follows :

- To increase the process ratio of the manufacturing process.
- To reduce the overall lead time.
- To ensure the smooth flow of the process.
- To reduce the cost of the process.
- To eliminate the backtracking of the component as well as the rework operation on the component.

2. LITERATURE SURVEY

"The Machine that Changed the World (1990)" by Womack, Jones, and Roos[1] in this book The Value stream mapping was used first and later on it is discussed in "Lean Thinking(1996)" by Womack and Jones. By Karen Martin and Mike Osterling[2], Value Stream Mapping is the tool that shows operational waste and how to visualize the work, the broader use of value stream mapping as a methodology to transform leadership thinking and assure that customers are receiving a high level of value.

Antor Habib Chowdhury et al.[3] Lean tools like VSM, 5S, kaizen, Kanban are helpful to improve productivity and also helps to smooth the flow of material. It is difficult to use VSMin the case of multiple flows that merge. J. Oliveria, J.C. Sa et al.[4], The use of lean tools is a simple way and low-cost solution to achieve productivity and profitability, using a continuous focus on the elimination of waste through all the organization. Lean Tools are easy to used tools, they engage all the organization and assures the commitment of all from top to down, they assure are the way to empower the collaborators and turn visible all the results of theirs work.

Ana Luísa Ramos et al.[5] The unbalanced packagingline was balanced by using lean manufacturing and Simulation, by using simulation and leantools line get balanced and productivity increased merge. N. Sukdeo[6] 6 S comprises of 5S +safety to the concept of safety awareness in organization, by using 6 S. reduces wastages, improved quality and enhanced organizational performance.

F. K. DeLa-Cruz-to et al.[7] The authors use 5 S and Kanban cards to reduce the non-valueadded time and increase the profit of the company. By simulation study shows that reduce the downtime by 62%. Wai Kuan Cheong et al.[8] By changing the techniques of working and metrology tools, the author was able to reduce the non-value added activities like the unnecessary movement of workers and design the line ergonomically that helps to increase productivity.

Suman Kundgol et al.[9] By using VSM identified non value added time and to reduce this non value added time uses some of the lean tools. By using VSM improved the flow of the Process and reduced the bottleneck. Lijalem Mulugeta,[10] existing layout having problems of unnecessary material movement and transportation of components between work stations. Because of this, the line gets unbalanced and large inventory gets pile up which results in large work in process. By using lean tools able to solve this problem and increase productivity. Harish Kumar Banga et al.[11] In the old layout they found out major wastages like defects, excessive lead time and absentees and by using simulation modelling they improve decision making skills.

From these papers, we came to know how we can use VSM to detect waste and to apply proper lean tools to reduce waste. The above papers conclude that by reducing the wastages and using several types of lean tools and lean manufacturing techniques we can improve our process as well as the process ratio to increase our productivity

3. METHODOLOGY

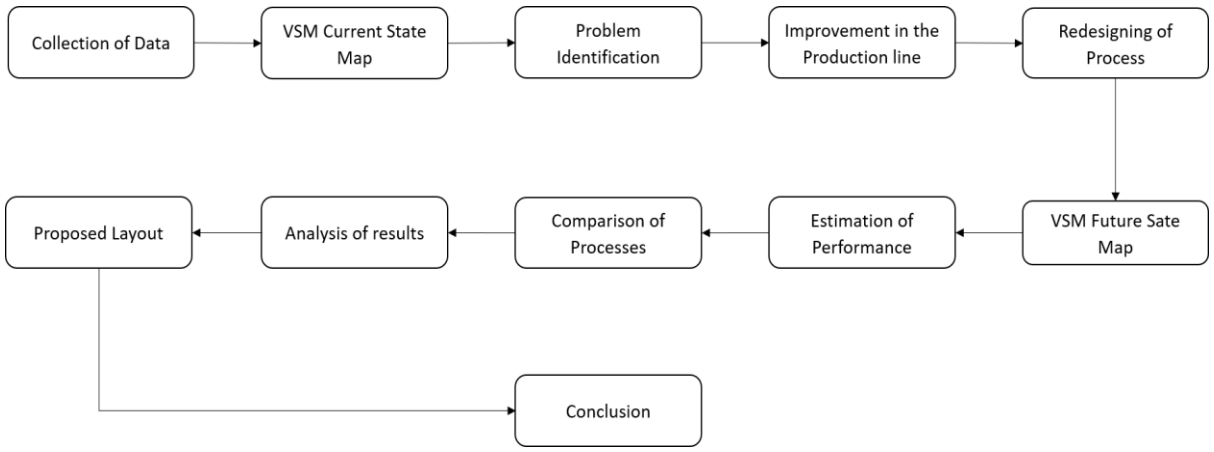


Figure 1: Methodology.

First, the data was collected from the manufacturing line. This includes the process layout, flow of the process, cycle time of each operation, no. of inventory, the distance between each machine, distance covered by the product from start to end, etc. By using this data, the Value Stream Map (VSM) was drawn. From VSM, the values of value-added time, nonvalue added time, process ratio, distance travelled by the component, number of inventories in the manufacturing line were acquired. After obtaining all the above points, the problems were identified from VSM. The problems encountered were: unnecessary motion of the component, a decent amount of scrap generation, rework process on the component, and because of rework the inventory got piled up. To reduce these problems, lean tools such as Kaizen, Poka Yoke, Pareto chart, and some other quality tools were incorporated. After the application of these tools, there was a small amount of improvement in the process. So the process was redesigned. Then the Future State Map was plotted with the improved processes and data associated with it. Then the comparison of both the results is done from current and future state maps to get the difference. This concludes that the process ratio was improved and the nonvalue added time was drastically reduced. By using the lean tools the productivity was improved.

3.1 Data Collection

To generate VSM of any process, data of the process is important. Also, collection of information about the manufacturing process and product related to it is mandatory. The information such as the flow of the process, cycle time for each

operation, the distance between each operation, number of inventories in process, etc. is also important.

3.2 Before Implementation of the Lean Tools

By collecting all necessary information, the current state map was drawn.

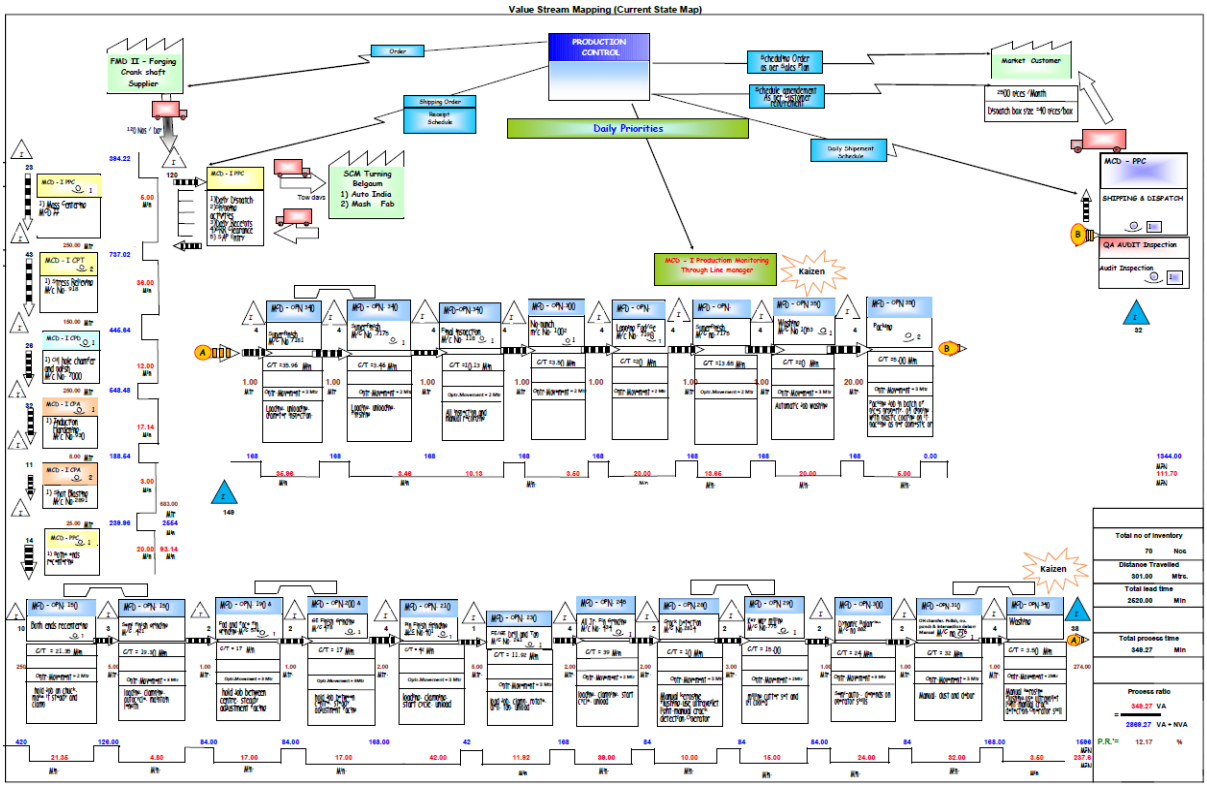


Figure 2: Current State VSM.

3.3 Current State Map Summary

By drawing current state VSM, the values acquired are as follows:

Table 1: Summary of Current State Map

Sr.No.	Parameters	Before
1	VA	349.27
2	NVA	2520
3	VA / VA + NVA Ratio	12.17
4	Distance Travelled	301
5	Inventory	66

3.4 Problem Identification & Their Solution

After drawing VSM for the current state, analysis was done on all the processes on the floor. The problems that lead to an increase in the NVA activities were identified. The problems are as follows:

1) Excessive Material Movement

Excessive or unnecessary material movement is one of the wastage. Excessive material movement lead to an increase in the overall cost of the product and also increases the lead time.

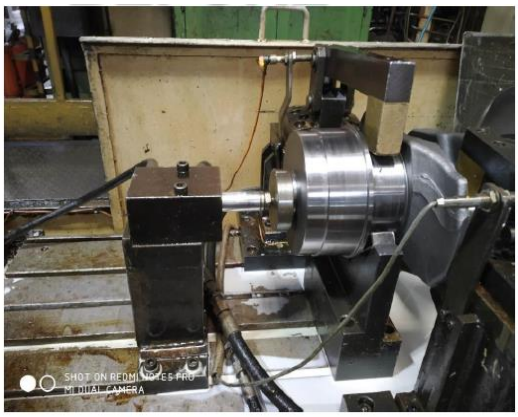
Problem Identified: The old layout of the industry had a centralized packaging area for all the manufacturing lines. As there was a centralized packaging area for all manufacturing lines, the distance from washing operation to packaging operation earlier was 20m. Because of this, there was an excessive movement of the component and also a lot of material was required to pack the component and then shift it to the centralized packaging area. During the movement of finished components to the packaging area, the company was concerned about the quality of the component as the component could get damaged due to mishandling. So to avoid damage to the job and to transfer the finished components safely, VCI bags, plastic caps, and corrugated sheets were used. Which eventually increases the overall cost of the production.

Solution: To avoid this excessive material movement, a separate packaging area was built in the manufacturing line itself. Therefore the distance between washing to packing operation was reduced to 1m. Hence the additional material required for packing was eliminated. It helped to increase productivity by reducing lead time and cost as well.

2) Scrap Generation

Problem Identification: In all manufacturing industries, scrap is one of the major waste. In the manufacturing line, there were several reasons for the scrap generation. A sheet was made with the list of all the reasons which caused the scrap along with the number of scraps generated for the particular reason. By using this list, the Pareto chart was drawn. From the Pareto chart, the major scrap was generated at the flange hole drilling operation machine. The main reason was the reverse loading of the job on the machine. Because of the reverse loading of the job, more scrap was generated and the number of accidents caused due to this was high.

Solution: To avoid and eliminate the problem Poka-Yoke was introduced on the flange hole drilling machine. The mechanical stopper was manufactured and attached to the machine which ensures that the job will be loaded in the correct way and from the correct side. By implementation of the Poka Yoke, there will be no scrap generated in the near future.



Job reverse loading possible, No stopper arrangement

Figure 3: Before Introducing Poka Yoke on the Flange Hole Drilling Process.

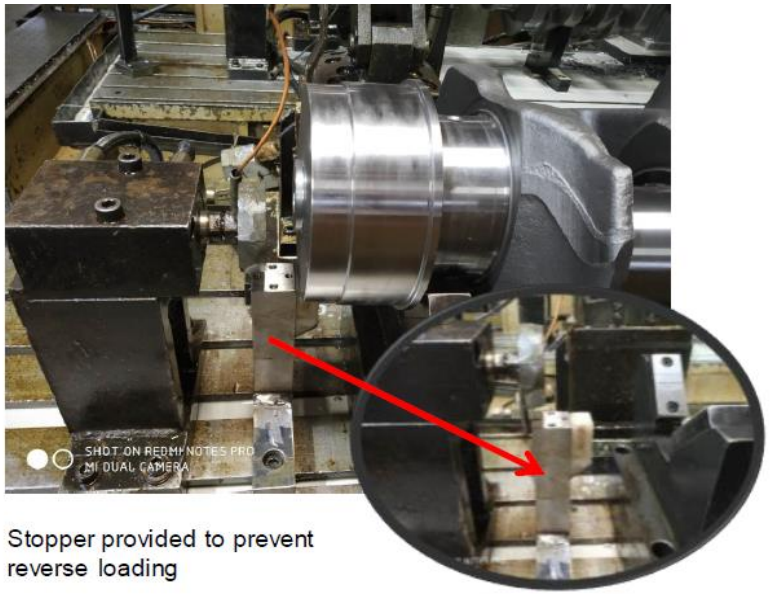


Figure 4: After Introducing Poka Yoke onthe Flange Hole Drilling Process.

3) Missing of the Dowel Pin

Problem identification: Sometimes the operator forgets to fit the dowel pin during the number punching operation. Due to this, there was an increase in customer complaints. Also, there was a decrease in demand for the same reason.

Solution: To solve the problem another Poka-Yoke tool was introduced to the number punching machine. An interlocking system was provided with a sensor where it would detect the dowel pin. If the dowel pin is missing, then the machine will not start and the operator will be unable to operate the machine. Dueto this arrangement, there was zero customer complaint about the missing dowel pin.

Figure 5: Before Introducing Poka Yoke on the Number Punching Operation.

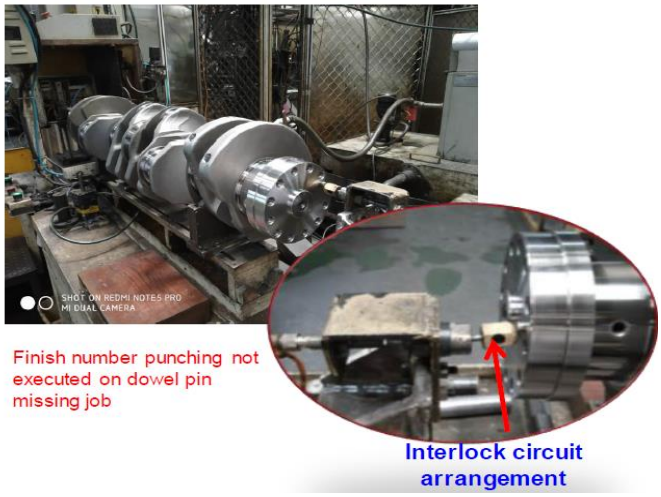


Figure 6: After Introducing Poka Yoke on the Number Punching Operation.

4) Rework of Operations

Problem identified: In the process, there were two washing operations as mentioned in the VSM. Due to both washing operations, there was a rework of the operation on the component. Due to this, the cycle time was more and extra work was done on the job.

Solution: One washing operation was eliminated from the process which reduced the cycle time as well as the lead time from the process. This leads to the elimination of the backtracking of the component which further leads to a reduction in the inline inventory.

As one washing operation was eliminated from the process, Kaizen was implemented for the remaining washing operation for improvement. The following Kaizen points were implemented to improve the process as well as the quality of the job.

Kaizen Points:

- Checking the TPM checklist at the beginning of the first shift and recording the observations for the same.
- Daily monitoring of the checklist is to be done for the process improvement.
- Tank cleaning frequency is monitored by applying the board on the tank itself.
- Boards were applied to the filter to know the date when the filter needs to be changed.
- Pictorial boards were applied for easy understanding to the workers.

Figure 7: Kaizen Implementation on Washing Operation.

3.5 After Implementation of Lean Tools

By using Kaizen, Poka Yoke, and other quality tools the manufacturing process was improved and the Future state map was drawn.

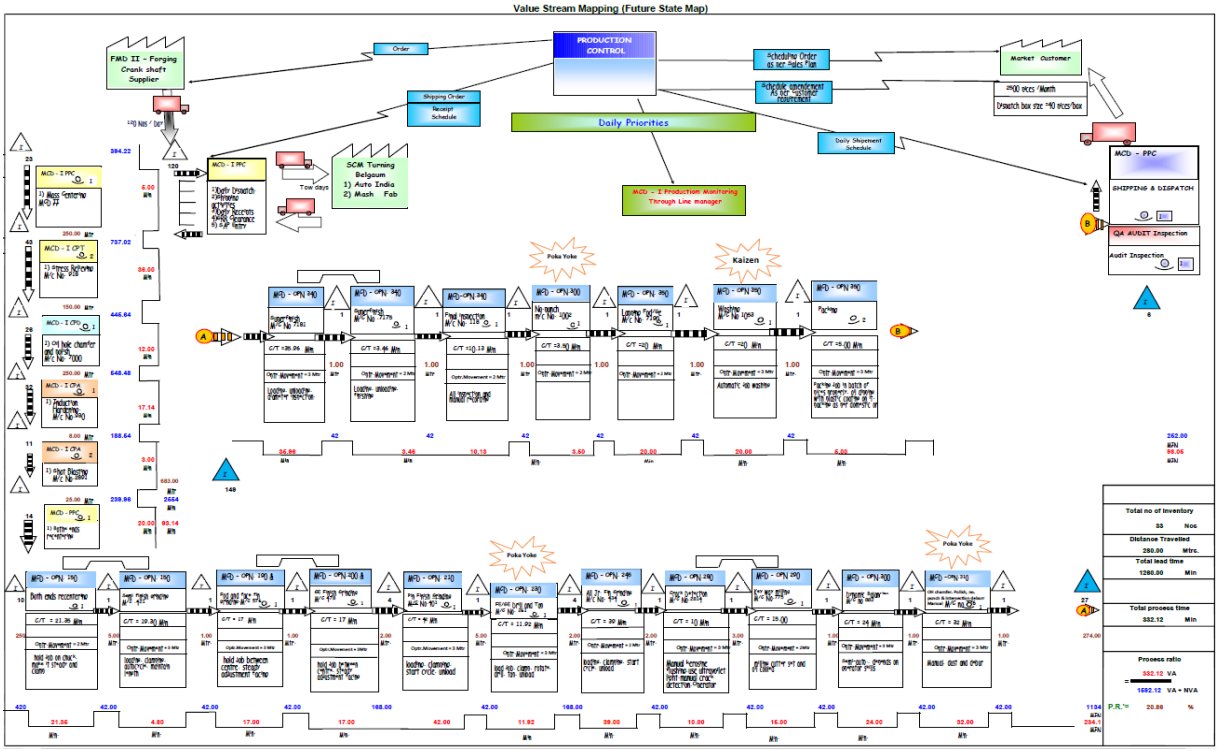


Figure 8: Future State VSM.

4. RESULTS

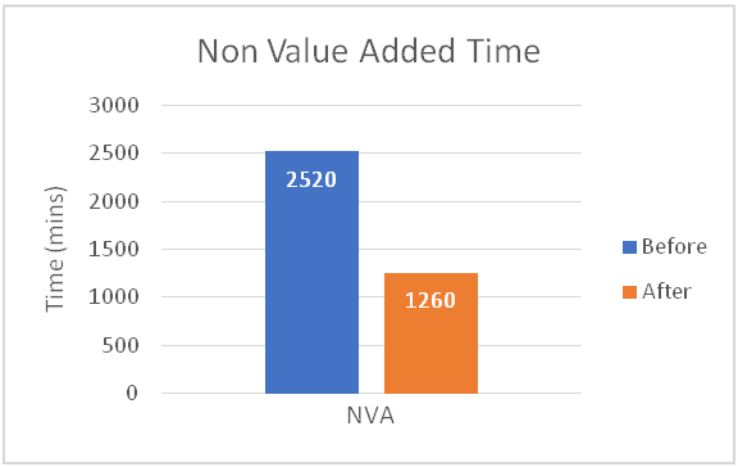
The results obtained before and after implementation of the lean tools are shown in Table No. 2

Table 2: Comparison of Results

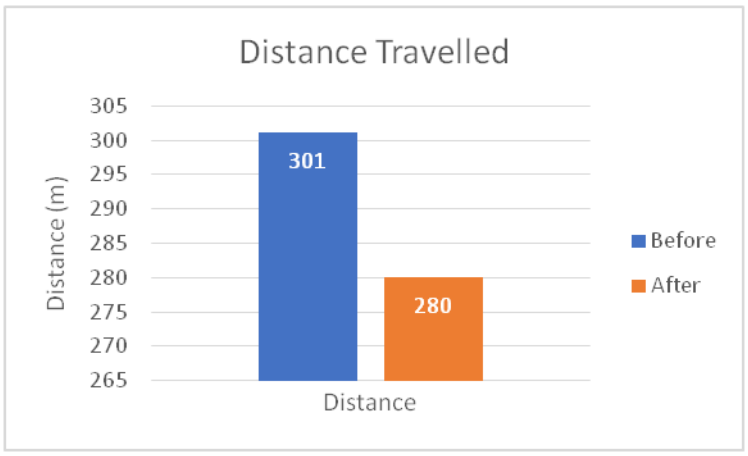
Sr.No.	Parameters	Before	After
1	VA	349.27	332.12
2	NVA	2520	1260
3	VA / VA + NVA Ratio	12.17	20.86
4	Distance Travelled	301	280
5	Inventory	66	33

From table No. 2, by implementing the lean tools the reduction of the non-value added time was from 2520 mins to 1260 mins.

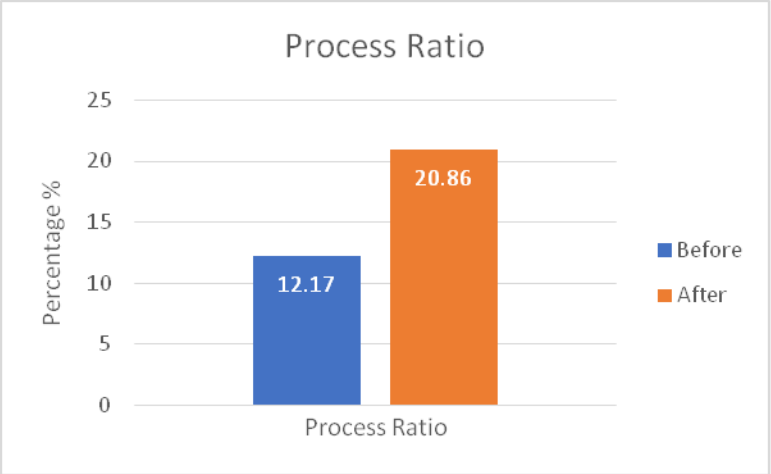
The waste of motion and travelling distance for transportation of the component was reduced by 21m. By reducing these wastes the inventory was also reduced. The most important factor for which the lean tools were implemented was productivity. By applying these tools and by the reduction of various types of wastes the productivity of the manufacturing line was increased by 8.69 %.



Graph 1: Comparison of NVA Time.



Graph 2: Comparison of the Distance Travelled by the Component.



Graph 3: Comparison of the Process Ratio.

5. CONCLUSIONS

The lean tools are the tools that are used for identifying and removing waste. This paper is intended to apply some of the lean tools to the crankshaft industry. The tools applied in this industry were Value Stream Map, Kaizen, Poka-yoke. The too lsused in the manufacturing line has shown excellent result. By implementing these lean tools in the manufacturing line, the non-value added time was reduced which leads to customer satisfaction. The lead time, scrap generation percentage we realso reduced and the process ratio of the manufacturing line was increased. Based on the data collected from the company, these techniques have helped a lot for manufacturing more components in lesser time. This also helps in fulfilling the customer demand before the deadline.

So these lean tools are very effective tools for the industries for reducing waste and improving the productivity of their manufacturing processes.

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